(12) UK Patent Application (19) GB (11) 2 369 471 (13) A

(43) Date of A Publication 29.05.2002

(21) Application No 0028699.7

(22) Date of Filing 24.11.2000

(71) Applicant(s)
Deson-IES Engineering Ltd
(Incorporated in Hong Kong)
13th-14th Floors, North Point, Hong Kong

(72) Inventor(s)
Albert Ting Pat So

(74) Agent and/or Address for Service
Lloyd Wise, Tregear & Co
Commonwealth House, 1-19 New Oxford Street,
LONDON, WC1A 1LW, United Kingdom

(51) INT CL^7
H02J 13/00

(52) UK CL (Edition T)
G4H HNEM H1A H13D H13F H60
U1S S1727 S1729 S1931 S1967 S1976 S1978 S2062 S2124 S2206 S2215

(56) Documents Cited
GB 2244830 A **GB 2218231 A**
WO 95/24759 A1

(58) Field of Search
UK CL (Edition S) **G4H HNEC HNEE HNEL HNEM HRBE HRBS HRCE HRCS**
INT CL^7 **H02J , H04Q**
Online: WPI, EPODOC, PAJ

(54) Abstract Title
Intelligent building management system

(57) A system for intelligently controlling the supply of power to a plurality of electrical appliances distributed throughout a building. The system is formed of a plurality of switches, with the switches being provided with a signal module and a power module. The switches interconnect to form a network, which may be connected to a communications network via at least one router. Each power module provides power to at least one associated appliance, but any power module in the network can be controlled by any signal module. Each signal module comprises a user interface whereby a user may input a command, e.g. through the Internet, an intranet or a telephone connection. The status of the power modules may be provided to the router(s) and stored thereon, and viewed from the communications network. Network configuration information may also be stored at the router(s).

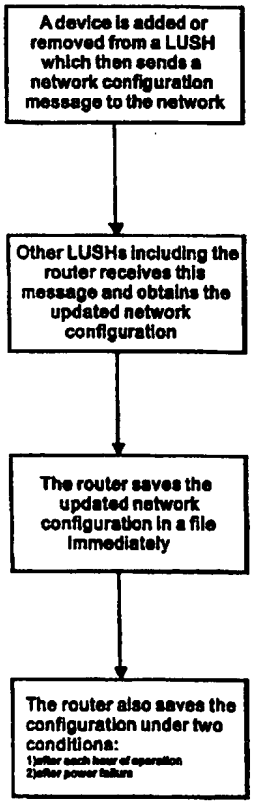

Fig.6

GB 2 369 471 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

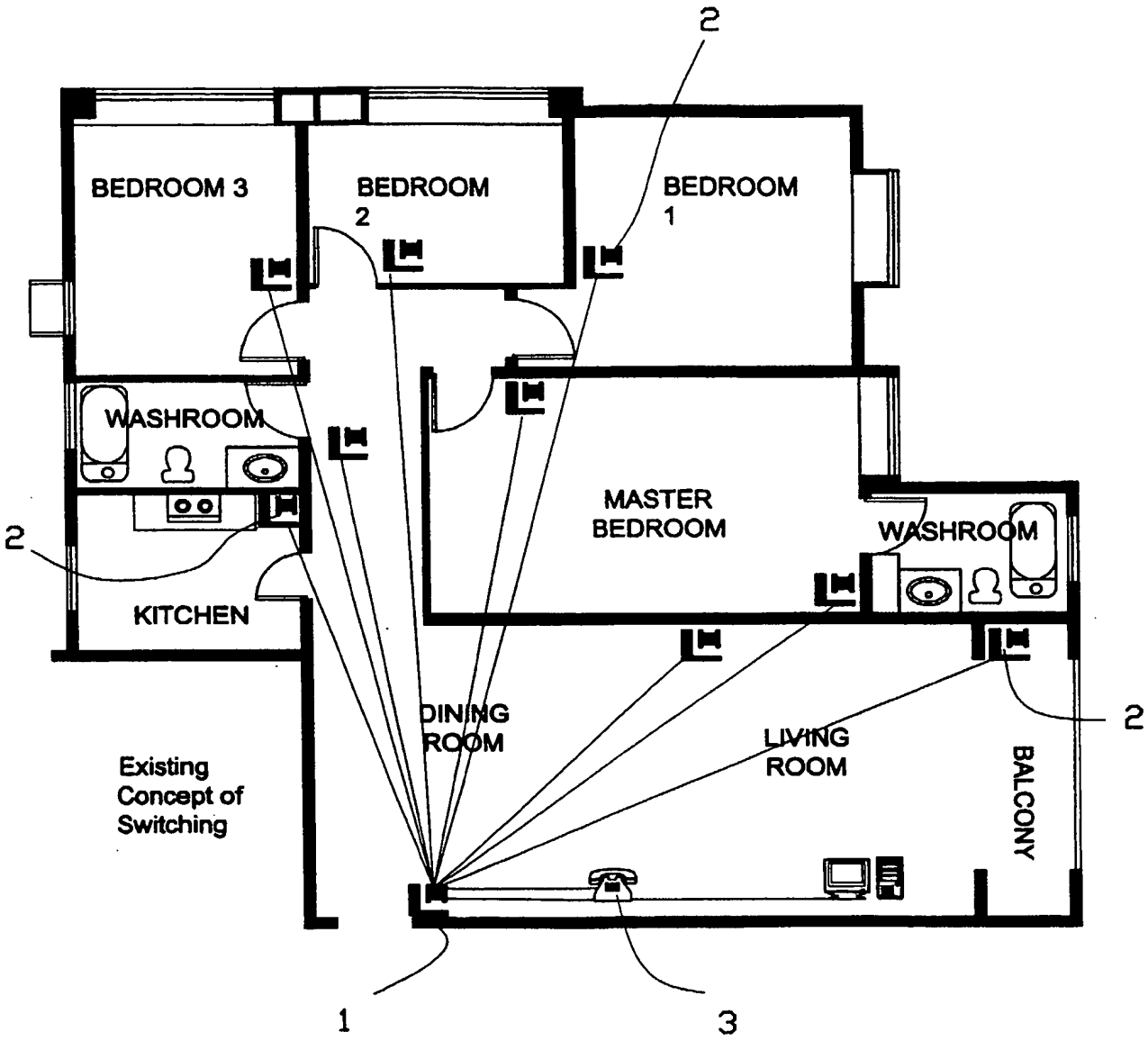
BEDROOM 3
BEDROOM 2
BEDROOM 1
WASHROOM
MASTER BEDROOM
WASHROOM
KITCHEN
DINING ROOM
LIVING ROOM
BALCONY
Existing Concept of Switching
2
2
2
1
3

Fig.1

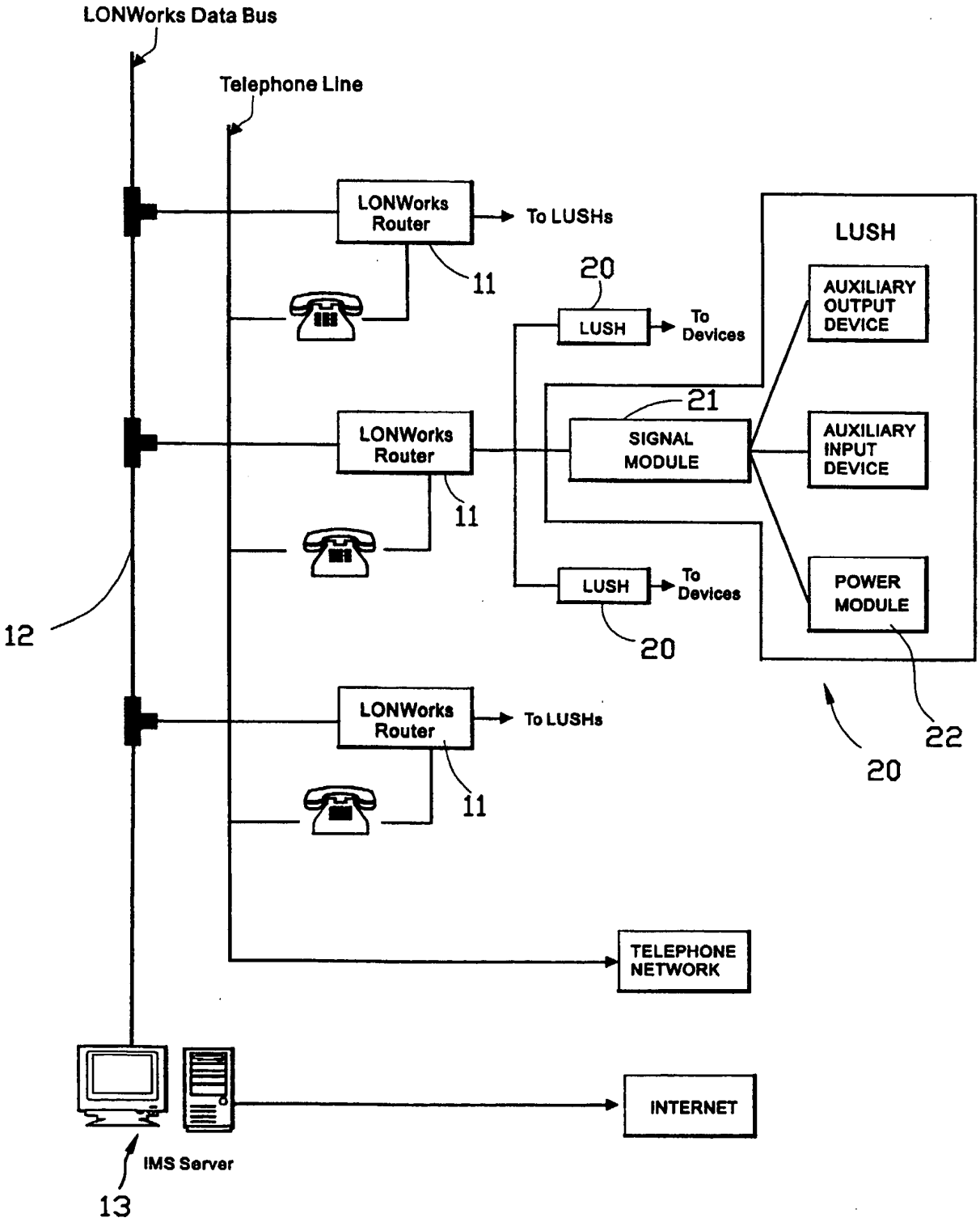
LONWorks Data Bus
Telephone Line
LONWorks Router
To LUSHs
11
20
LUSH
To Devices
LUSH
AUXILIARY OUTPUT DEVICE
21
SIGNAL MODULE
AUXILIARY INPUT DEVICE
POWER MODULE
22
20
12
TELEPHONE NETWORK
INTERNET
IMS Server
13

Fig.2

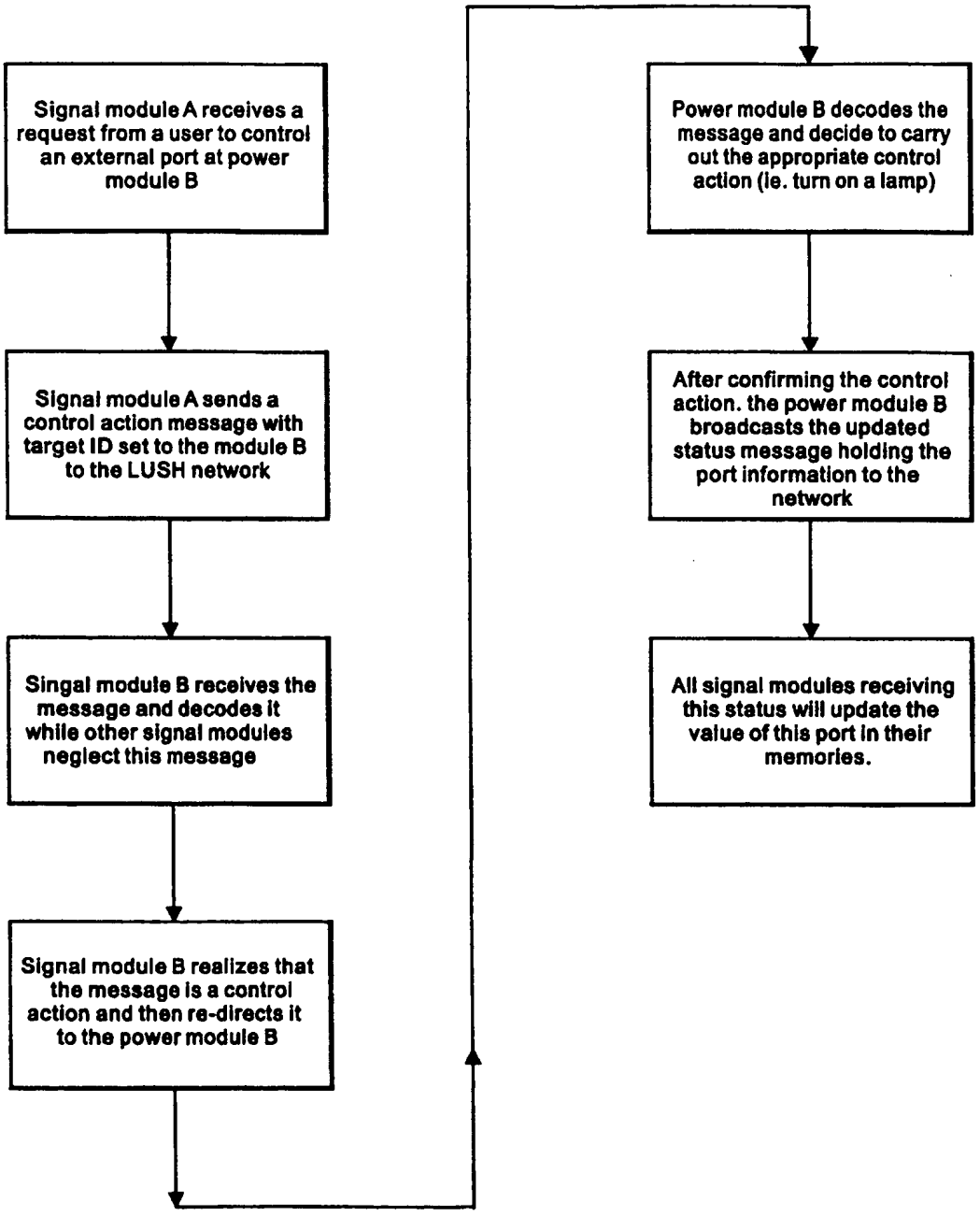
Signal module A receives a request from a user to control an external port at power module B
Signal module A sends a control action message with target ID set to the module B to the LUSH network
Singal module B receives the message and decodes it while other signal modules neglect this message
Signal module B realizes that the message is a control action and then re-directs it to the power module B
Power module B decodes the message and decide to carry out the appropriate control action (ie. turn on a lamp)
After confirming the control action. the power module B broadcasts the updated status message holding the port information to the network
All signal modules receiving this status will update the value of this port in their memories.

Fig.3

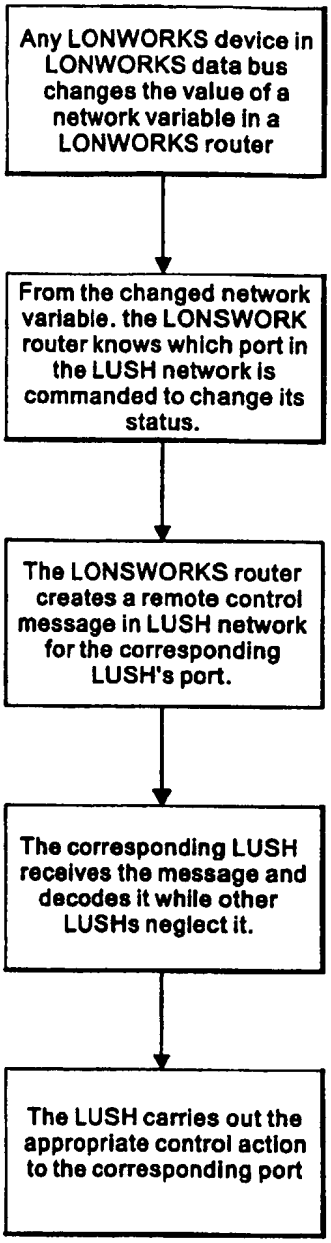
Any LONWORKS device in LONWORKS data bus changes the value of a network variable in a LONWORKS router
From the changed network variable. the LONSWORK router knows which port in the LUSH network is commanded to change its status.
The LONSWORKS router creates a remote control message in LUSH network for the corresponding LUSH's port.
The corresponding LUSH receives the message and decodes it while other LUSHs neglect it.
The LUSH carries out the appropriate control action to the corresponding port

Fig.4

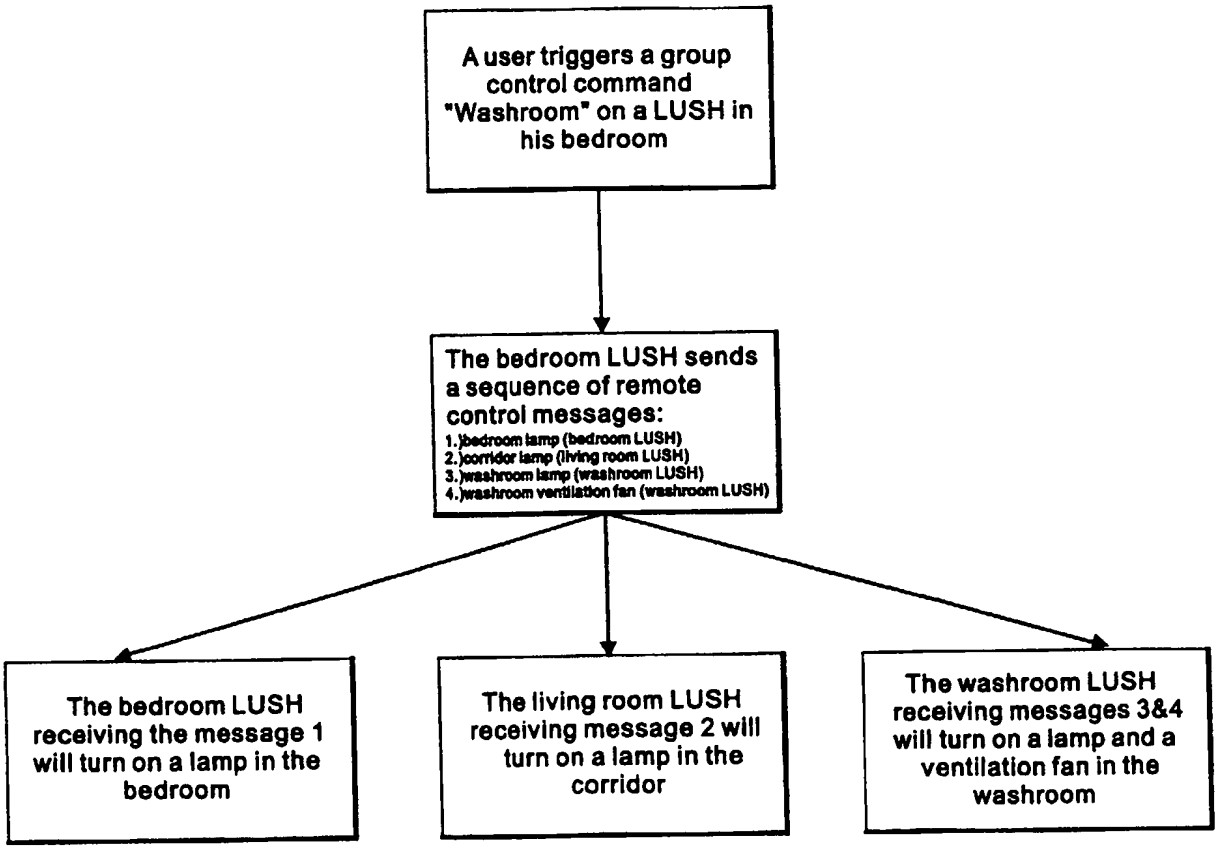
A user triggers a group control command "Washroom" on a LUSH in his bedroom
The bedroom LUSH sends a sequence of remote control messages:
1.)bedroom lamp (bedroom LUSH)
2.)corridor lamp (living room LUSH)
3.)washroom lamp (washroom LUSH)
4.)washroom ventilation fan (washroom LUSH)
The bedroom LUSH receiving the message 1 will turn on a lamp in the bedroom
The living room LUSH receiving message 2 will turn on a lamp in the corridor
The washroom LUSH receiving messages 3&4 will turn on a lamp and a ventilation fan in the washroom

Fig.5

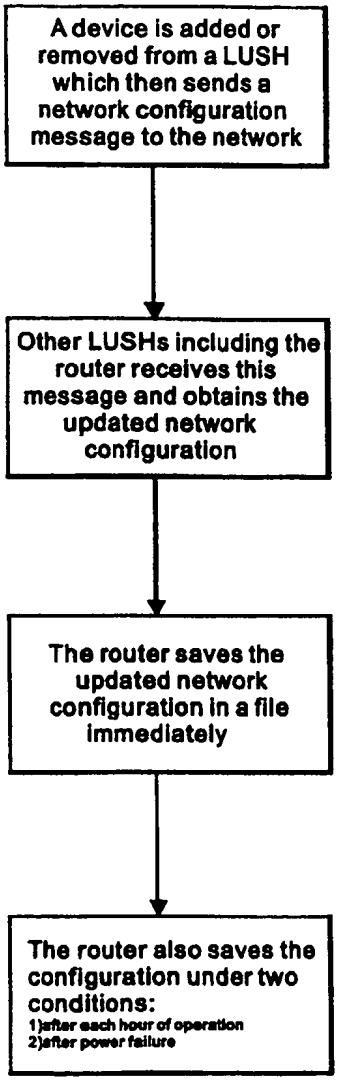
A device is added or removed from a LUSH which then sends a network configuration message to the network
Other LUSHs including the router receives this message and obtains the updated network configuration
The router saves the updated network configuration in a file immediately
The router also saves the configuration under two conditions:
1)after each hour of operation
2)after power failure

Fig.6

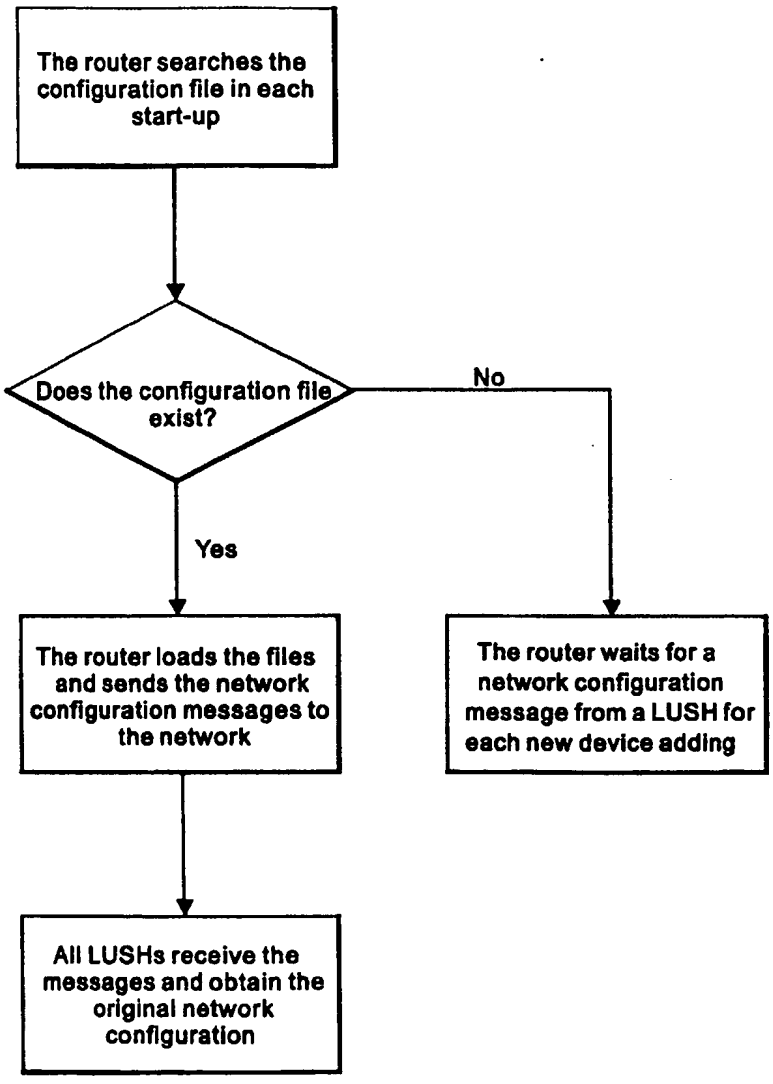
The router searches the configuration file in each start-up
Does the configuration file exist?
No
Yes
The router loads the files and sends the network configuration messages to the network
The router waits for a network configuration message from a LUSH for each new device adding
All LUSHs receive the messages and obtain the original network configuration

Fig.7

INTELLIGENT BUILDING MANAGEMENT SYSTEM

This invention relates to a building management system, and in particular to such a system adapted for home or office application and which is designed with distributed intelligence.

Whereas in a traditional building individual appliances such as lighting, heating and air-conditioning units would have been individually controlled by users operating individual controls for each appliance, in recent years there has been a tendency to move towards building management systems in which control means are provided for controlling such appliances. This is particularly true for large office buildings, but is increasingly becoming true also for houses, apartments and other residential buildings. In its most simple form, such a conventional building management system may comprise a centralised control of the heating and lighting in a building, for example allowing heating or lighting to be turned on or off at given times.

While such control systems were originally designed with large buildings such as office buildings, department stores, hotels, hospitals, schools and so on in mind, increasingly homes and apartments are being built with building management systems in mind and the "intelligent home" is becoming closer to a practical reality. In such a home for example, it would be possible to operate the heating or air-conditioning remotely while travelling home from work, or it would be possible to switch on the hot water system when one lands at an airport following a holiday or business trip.

While such homes can be designed and built with current technologies, they have not yet received widespread acceptance. There remains a need for a flexible, reliable and

easy to use building management system that is of relatively low-cost. The system should not only be easy to incorporate into new buildings, but it should be possible to install it easily into older homes.

One known system is shown very schematically in Fig.1. This system is provided with a single controller 1 for one home that may control up to 32 different appliances 2 located at various points around the home. These appliances may be lights, air-conditioning units, heating systems, television sets and so on. The controller may be provided with programmable time-control means so that – for example – certain lights may be switched on at a given time regardless of whether the occupant is at home. Another feature of this prior system is that it may be operated remotely through a telephone modem 3 with voice confirmation feedback.

One disadvantage of this system is that it is useful only for an individual home and cannot be generalised into a wide-area system. More seriously still, it is a centralised system in which all the control functions are localised at the control means. Failure of the control means will result in failure of the entire system. Furthermore changes to the operation of the system must be input by a user at a control interface provided at the control means. These disadvantages mean that the system is seriously lacking in flexibility, for example it is very difficult to add new appliances into the system once it has been set up.

According to the present invention there is provided a management system for controlling a plurality of electrical appliances in a building, comprising: a plurality of switches, each said switch comprising a signal module and a power module, said switches being interconnected to form a switch network, and each said power module

being adapted to supply power to at least one said appliance, wherein each said signal module is adapted to issue signals for controlling the power module of any switch in said switch network.

Preferably each signal module comprises a user interface whereby a user may input a command.

In a preferred embodiment of the invention the switch network is connected to a communications network via at least one router, and preferably a user may input a command to the switch network via the communications network, for example either through the Internet, through an intranet or through a telephone connection.

Preferably the status of the power modules is provided to the at least one router whereby the status of the outputs of the power modules may be viewed from the communications network. In addition the status of the outputs of the power modules may be updated at the router at regular intervals. The router may include permanent memory storage means for storing the network configuration, and the network configuration may be saved following power failure to the network. In particular, the configuration may be saved in a configuration file, and wherein after power is restored the router generates a network configuration message from the contents of said configuration file.

One advantage of the present invention is that it is easier than prior proposals to add or remove appliances from the system without having to completely reconfigure the system. In a preferred embodiment of the invention when an appliance is added to or removed from the system a network configuration message is transmitted to the router by the signal module associated with the power module to which the appliance is added or from which the appliance is removed.

Preferably the communications network is an open protocol network. Preferably the switch network communication is via predefined protocols and wherein the at least one router is adapted to interface between said open protocol communications network and the predefined switch network protocols.

In a preferred embodiment the signal modules are adapted to receive inputs from auxiliary control devices, for example temperature sensors, humidity sensors, light sensors, fire alarms and security alarms.

Another advantage of the present invention is that appliances may be grouped together whereby a single signal issued by a signal module may operate said plurality of appliances.

Preferably the signal module is a low voltage device, for the sake of safety since this provides the user interface, and wherein the power module is a high voltage device.

Viewed from another broad aspect the present invention provides a management system for controlling a plurality of electrical appliances in a building, comprising: a first network formed of a plurality of switches in communication with each other, each said switch comprising means for supplying power to a number of electrical appliances and each said switch being provided with user input means whereby a user may input a command for controlling any electrical appliance within the system, and wherein said first network is connected to a second network, said second network being a communications network.

Viewed from another broad aspect the present invention provides a switch for a building management system comprising a signal module and a power module, wherein said signal module issues command signals in response to a user input, and wherein said

power module is an electronic power device provided with a plurality of output ports for providing power to a plurality of respective electrical appliances.

Some embodiments of the invention will now be described by way of example and with reference to the accompanying drawings, in which:-

Fig.1 is a schematic of the operating principle of a conventional prior art building management system,

Fig.2 is a block diagram illustrating the structure of the management system according to an embodiment of the present invention,

Fig.3 is a flowchart explaining an example of a message flow in the embodiment of Fig.2,

Fig.4 is a flowchart explaining another example of a message flow in the embodiment of Fig.2,

Fig.5 is a flowchart illustrating the concept of a group control in the embodiment of Fig.2,

Fig.6 is a flowchart illustrating the process of network configuration updating, and

Fig.7 is a flowchart illustrating the process of automatic network configuration recovery.

Referring firstly to Fig.2 there is shown schematically a first embodiment of a building management system in accordance with an embodiment of the invention. This system is a distributed management system based on a LONWork network. LONWork is an open protocol system developed by Echelon Corporation the protocols for which are openly available and will therefore not be described in detail here.

The system employs a plurality of switching devices (LUSH) 20 connected via a plurality of routers 11 to a LONWorks data-bus 12 and a server 13. The number and the location of the switches 20, and routers 11 may be varied as required by the particular requirements of a building or home to which the management system is to be installed.

Each switch 20 has the basic functions of switching on and off home appliances, and receiving input signals from control devices such as temperature and humidity sensors. In particular, each switch 20 comprises a number of sub-modules, and in particular a signal module 21 and a power module 22. The signal module 21 comprises means for connecting the switch to the data-bus 12 through a router 11 and is responsible for handling data transfer between its own switch and other switches, and the signal module also includes means for communicating with the power module 22. The signal module 21 may also receive inputs from auxiliary devices such as temperature sensors, humidity sensors and light meters, and may also provide signals to auxiliary output devices such as electric gates, alarms and so on as will be described further below. The signal module 21 may also include input means whereby a user may input a desired command to control an appliance.

The power module 22 comprises power electronics for supplying power to appliances under the control of the switch 20. The power module 22 will include a plurality of output ports to which appliances may be connected. Typical appliances include lighting, air-conditioning apparatus, fans, water heaters and so on. The power module 22 may therefore be a high-voltage device whereas the signal module 21 may be a low-voltage device. Because input commands from a user are input to the low-voltage signal module 21, the user is isolated from the high-voltage power module 22.

A switch 20 can communicate directly with all other switches 20. As such the switches 20 may be regarded as being disposed to form a first network, whereas the data-but and routers may be regarded as forming a second communications network. The communication between the switches of the first network may be performed through the power line carriers for existing buildings, or may be through dedicated twisted-pair cables for new buildings. Communication between a signal module 21 and a power module 22 may use predefined protocols, whereas communications on the data-bus may use standard LONWorks open protocols. The routers 11 may be designed to provide a conversion between these protocols whereby the status of any switch or module (for example information of the appliances connected to the power module and the status of output ports of the power module) may be seen from any other device connected to the data-bus. In particular, the status of each power output port of the power modules 22 is available to the network so that the whole network is aware of the status of every power output port (eg whether a light is on or off) and so that the status of the power output ports can be viewed from a distance.

An important feature of the present embodiment is that each signal module 21 and each power module 22 is provided with microprocessor means whereby the control of the appliances may be distributed across the network. Furthermore, the switches 20 are connected in a network in which multi-directional communications are available at all times and in which each switch is provided with its own ID. This means that the switches can communicate with each other and in particular, while appliances may be controlled by the signal module 21 of the switch 20 to which they are directly connected, they may

also be controlled from any other signal module. This provides not only greater flexibility than conventional systems, but also greater reliability.

As an example of the present invention, one can consider that a switch 20 will be provided for each room of a house or apartment and will include a power module 22 that supplies power to all the appliances in that room that the system is intended to control. For example, if the lighting in that room is to be controlled, a desired input may be made by a user to the signal module through a suitable interface. The signal module 21 will then send a control signal to the power module 22 to switch on or off or otherwise adjust the power supply to the lighting appliance in question in that room. In addition, however, a signal module 21 of a first switch 20 may be used to control the power module 22 of a second switch 20. In this way it is possible, for example, to control an appliance in one part of a building from a switch located in another part of the building. This has a number of advantages. To begin with it provides greater reliability in that the system can still function even if there is a failure in one signal module. Secondly it provides greater flexibility in that appliances in the building can be controlled from any location.

A first example will be given of a remote command that is generated within the switch network, which illustrates how it would be possible to turn on the lights in one room before leaving another. Fig.3 illustrates how this may be achieved. In a first step, one signal module A receives a control input from a user to control an appliance that is under the control of the power module of a second switch B. The signal module of switch A then sends a control message bearing a receiver ID equivalent to switch B across the switch network. The control message is picked up by the signal module of switch B and is ignored by all other signal modules (because of the presence of the ID corresponding to

switch B). Signal module B then passes the control message to its associated power module B which then acts upon the control signal in the appropriate manner and confirms the control action and broadcasts its current status to the network. It should be noted here that even if a user interface part of signal module B were not functioning, provided that signal module B had enough functionality to receive signals from the switch network and to pass them on to the power module B, then power module B could still be controlled by a user from a different signal module.

Because the status of all output power ports in the switch network are available to devices on the data-bus through the routers, a remote control can also be generated by any remote LONWorks device that is connected to the data-bus. A method by which a LONWorks device may be used to remotely control an appliance is shown in Fig.4. A LONWorks device connected to the LONWorks data-bus changes the value of a network variable (corresponding to an output port the status of which is to be changed) in a LONWorks router. From this changed network variable the LONWork router knows which port in the switch network is to be changed and the router then creates a remote control message in the switch network for the corresponding output port. The switch corresponding to the output port receives the remote message (which is ignored by the other switches) and acts upon it accordingly.

It will also be understood that the switches can be controlled remotely through either the Internet or an Intranet connection to the data-bus, or directly through telephone links to the routers.

A further advantage of the present invention, at least in its preferred forms, is that as the signal modules within each switch are microprocessor based, they can be

programmed by a user to create a group under a single control such that a number of ports can be controlled simultaneously. These ports can all come from a single switch or from a number of different switches. When a group control is triggered at one switch, a sequence of messages is transmitted to the switch network and the switches including ports that are part of the group will receive and act upon the message. An example of this is shown in Fig.5. A group may be defined called "Washroom" which includes the output ports corresponding to a bedroom lamp, corridor lamp, and washroom lamp and washroom fan. When this group control is instigated (for example during the night if a user wishes to go to the bathroom) the bedroom lamp, corridor lamp, washroom lamp and fan will all be operated even though they may correspond to the output ports if three different power modules of three different switches.

A further important advantage of the present invention is that additional devices and switches may be added to the network with minimum difficulty. Fig.6 shows how the system may be updated when a new device is added to (or removed from) a switch. When a device is added or removed to or from a switch, the signal module of the switch will send a network configuration message to the communications network advising of this change and the updated network configuration is automatically saved in a file. To achieve this at least one router may be provided with a permanent storage device and with a battery to allow the storage to continue to function in the event of power failure.

In order to facilitate network recovery the router may also save the network configuration at regular intervals, for example every hour, and also after a power failure. Fig.7 is a flowchart showing the automatic recovery of the network following power failure. Once power is re-established the router searches for the configuration file and

once it has been found the router loads the file and sends a configuration message to the network. The configuration message is received and acted upon by all switches in order to obtain the original configuration that existed before the power failure.

CLAIMS

1. A management system for controlling a plurality of electrical appliances in a building, comprising: a plurality of switches, each said switch comprising a signal module and a power module, said switches being interconnected to form a switch network, and each said power module being adapted to supply power to at least one said appliance, wherein each said signal module is adapted to issue signals for controlling the power module of any switch in said switch network.

2. A management system as claimed in claim 1 wherein each said signal module comprises a user interface whereby a user may input a command.

3. A management system as claimed in claim 1 or 2 wherein said switch network is connected to a communications network via at least one router.

4. A management system as claimed in claim 3 wherein a user may input a command to said switch network via said communications network.

5. A management system as claimed in claim 4 wherein said command may be input by a user through the Internet, through an intranet or through a telephone connection.

6. A management system as claimed in any of claims 3, 4 or 5 wherein the status of said power modules is provided to said at least one router whereby the status of said power modules a may be viewed from said communications network.

7. A management system as claimed in any of claims 3 to 6 wherein the status of said power modules is updated at said router at regular intervals.

8. A management system as claimed in any of claims 3 to 7 wherein said router includes permanent memory storage means for storing the network configuration, and wherein the network configuration is saved following power failure to said network.

9. A management system as claimed in claim 8 wherein said configuration is saved in a configuration file, and wherein after power is restored said router generates a network configuration message from the contents of said configuration file.

10. A management system as claimed in any of claims 3 to 9 wherein when an appliance is added to or removed from the system a network configuration message is transmitted to said router by the signal module associated with the power module to which said appliance is added or from which said appliance is removed.

11. A management system as claimed in any of claims 3 to 10 wherein said communications network is an open protocol network.

12. A management system as claimed in claim 11 wherein said switch network communication is via predefined protocols and wherein said at least one router is adapted to interface between said open protocol communications network and the predefined switch network protocols.

13. A management system as claimed in any preceding claim wherein said signal modules are adapted to receive inputs from auxiliary control devices.

14. A management system as claimed in claim 13 wherein said auxiliary control devices include temperature sensors, humidity sensors, light sensors, fire alarms and security alarms.

15. A management system as claimed in any preceding claim wherein a plurality of appliances may be grouped whereby a single signal issued by a signal module may operate said plurality of appliances.

16. A management system as claimed in any preceding claim wherein said signal module is a low voltage device and wherein said power module is a high voltage device.

17. A management system for controlling a plurality of electrical appliances in a building, comprising: a first network formed of a plurality of switches in communication with each other, each said switch comprising means for supplying power to a number of electrical appliances and each said switch being provided with user input means whereby a user may input a command for controlling any electrical appliance within the system, and wherein said first network is connected to a second network, said second network being a communications network.

18. A switch for a building management system comprising a signal module and a power module, wherein said signal module issues command signals in response to a user input, and wherein said power module is an electronic power device provided with a plurality of output ports for providing power to a plurality of respective electrical appliances.

19. A switch as claimed in claim 18 wherein said switch is provided with means for connecting to another said switch to form a switch network.

Application No: GB 0028699.7 16/ **Examiner:** Melanie Gee
Claims searched: 1-17 **Date of search:** 28 June 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): G4H (HNEC, HNEE, HNEL, HNEM, HR BE, HRBS, HRCE, HRCS)

Int Cl (Ed.7): H02J; H04Q

Other: Online: WPI, EPODOC, PAJ

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2244830 A	(ECHELON SYSTEMS), see page 3 line 1 - page 15 line 7, and page 21 line 1 - page 26 line 17.	
A	GB 2218231 A	(THE PLESSEY COMPANY), see e.g. abstract.	
X	WO 95/24759 A1	(PARK), see abstract, page 10 lines 3-8 and e.g. claim 1.	1, 2, 13, 14, 17

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.